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Influence of the domain structure on piezoelectric, dielectrics properties of relaxor SBN single crystals

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We have studied influence of the initial domain structure on piezoelectric, dielectrics properties of $Sr_xBa_{1-x}Nb_2O_6$ (SBNx) single crystals. SBN61 undoped, Ce and Ni doped single crystals were grown in Prokhorov General Physics Institute of RAS. The studied samples were cut normally to the polar axis and carefully polished.

The local polarization reversal, piezoelectric and dielectrics properties were studied in samples with initial domain structure created by: (1) zero-field cooling, (2) in-field cooling, (3) scanning by biased tip, (4) scanning by electron beam, (5) partial polarization reversal.

The domain structure after zero-field cooling represented a mixture of the nanoscale fractal-type maze domains. The geometry of the as-grown domain structure was characterized by fractal dimension and average correlation length.

The local switching in SBN crystals with various initial domain states using conductive tip of scanning probe microscope (SPM) was studied. The dependences of effective domain radius on the voltage and pulse duration were derived. The domain "shape factor", wall mobility, and threshold voltage were obtained. We proposed application of the "shape factor" of the domains formed by local switching for quantitative characterization of the domain state. The obtained results allowed to reveal the most effective method for the creation of a single domain state.

The temporal relaxation of the polarized state created by conductive SPM tip was investigated at various temperatures. It has been shown that the radius of created domains decreasing with temperature. The difference between piezoelectric responses in the polarized areas produced by application of the field of opposite sign (contrast) has been obtained. The average value of the induced contrast decreases during heating for all investigated crystals. Below the freezing temperature the induced state remains stable after an initial relaxation. Above the freezing temperature the induced state is unstable and gradually decays with time. The state stability is affected by the measuring conditions, notably continuous scanning results in a faster decay. It was shown that increasing of the field amplitude and pulse duration leads to higher stability. The polarized state created in the single domain state was remarkably more stable than in the multi-domain one. The obtained effects are attributed to decrease of the induced polarization and backswitching of the polarized area under the action of the depolarization field.

The peculiarities of integral piezoelectric effect and dielectric permittivity were studied. The frequency dependences of piezoelectric coefficient were obtained. The temperature and frequency dependences of dielectric permittivity were measured. The chemical composition of the surface was studied by X-ray photoelectron spectroscopy.

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1. V.A. Shikhova, V.V. Fedorovyh, A.P. Turygin, L.V. Gimadeeva, D.S. Chezganov, E.O. Vlasov, D.O. Alikin, L.I. Ivleva, A.L. Kholkin, V.Ya. Shur, *Ferroelectrics* **525**, 100 (2018).
2. V.Ya. Shur, V.A. Shikhova, D.O. Alikin, V.A. Lebedev, L.I. Ivleva, J. Dec, D.C. Lupascu, V.V. Shvartsman, *Scientific Reports* **7**, 125 (2017).